Is collapse of the Atlantic Ocean circulation really imminent? Icebergs' history reveals some clues

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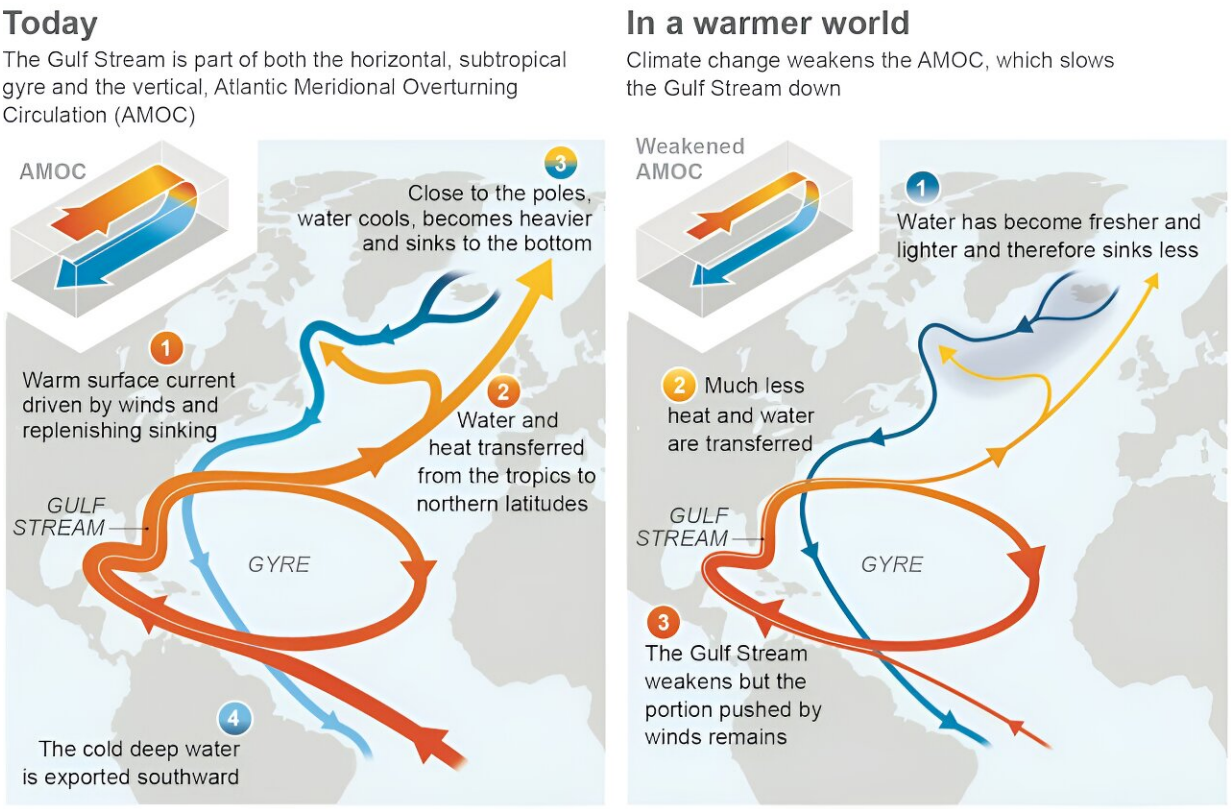


How the Atlantic Ocean circulation would change as it slowed. Credit: IPCC 6th Assessment Report

When people think about the risks of climate change, the idea of abrupt changes is pretty scary. Movies like "The Day After Tomorrow" feed that fear, with visions of unimaginable storms and populations fleeing to escape rapidly changing temperatures.

While Hollywood clearly takes liberties with the speed and magnitude of disasters, several recent studies have raised real-world alarms that a crucial ocean current that circulates heat to northern countries might shut down this century, with potentially disastrous consequences.

That scenario has happened in the past, most recently more than 16,000 years ago. However, it relies on Greenland shedding a lot of ice into the ocean.

Our new research, published in the journal *Science*, suggests that while Greenland is indeed losing huge and worrisome volumes of ice right now, that might not continue for long enough to shut down the current on its own. A closer look at evidence from the past shows why.

Blood and water

The Atlantic current system distributes heat and nutrients on a global scale, much like the human circulatory system distributes heat and nutrients around the body.

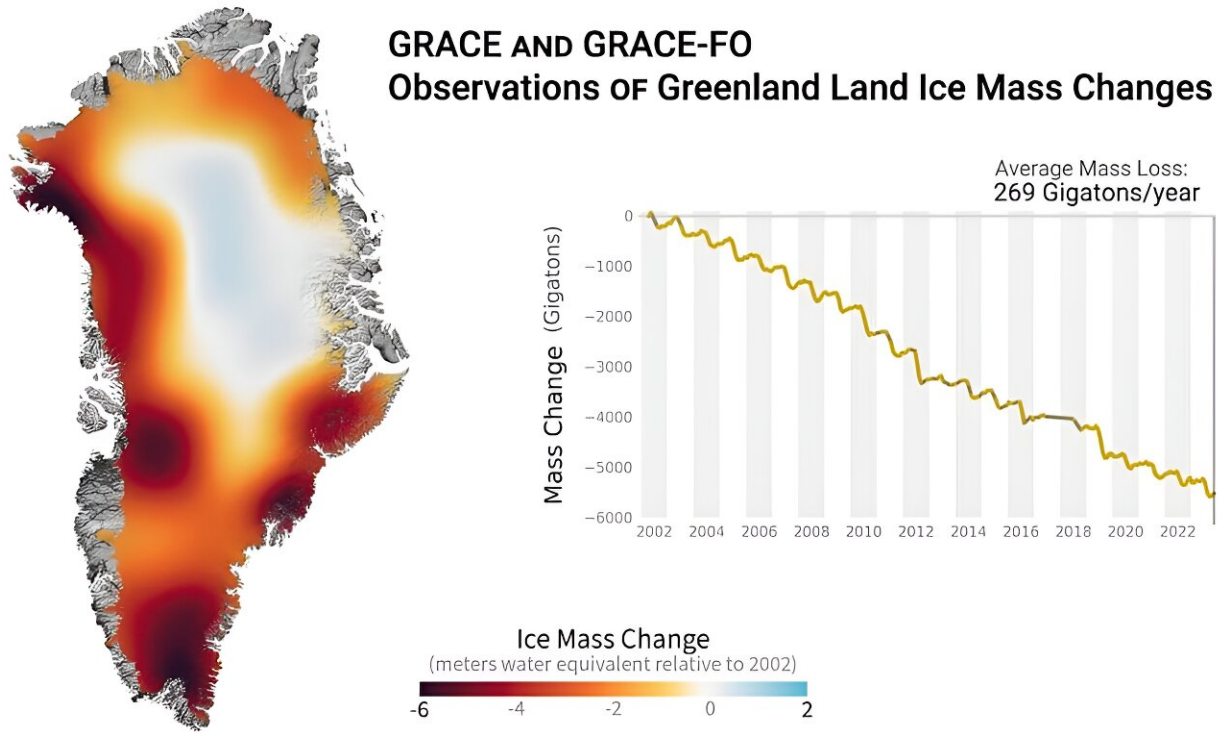
Warm water from the tropics circulates northward along the U.S. Atlantic coast before crossing the Atlantic. As some of the warm water evaporates and the surface water cools, it becomes saltier and denser. Denser water sinks, and this colder, denser water circulates back south at depth. The variations in heat and salinity fuel the pumping heart of the system.

If the Atlantic circulation system weakened, it could lead to a world of climate chaos.

Ice sheets are made of fresh water, so the rapid release of icebergs into the Atlantic Ocean can lower the ocean's salinity and slow the pumping heart. If the surface water is no longer able to sink deep and the circulation collapses, dramatic cooling would likely occur across Europe and North America. Both the Amazon rain forest and Africa's Sahel region would become dryer, and Antarctica's warming and melting would accelerate, all in a matter of years to decades.

Today, the Greenland ice sheet is melting rapidly, and some scientists worry that the Atlantic current system may be headed for a climate tipping point this century. But is that worry warranted?

To answer that, we need to look back in time.



Greenland's ice loss, measured from the Grace and Grace-FO satellites. Credit: NASA

A radioactive discovery

In the 1980s, a junior scientist named Hartmut Heinrich and his colleagues extracted a series of deep-sea sediment cores from the ocean floor to study whether nuclear waste could be safely buried in the deep North Atlantic.

Sediment cores contain a history of everything that accumulated on that part of the ocean floor over hundreds of thousands of years. Heinrich found several layers with lots of mineral grains and rock fragments from land.

The sediment grains were too large to have been carried to the middle of the ocean by the wind or ocean currents alone. Heinrich realized they must have been brought there by icebergs, which had picked up the rock and mineral when the icebergs were still part of glaciers on land.

The layers with the most rock and mineral debris, from a time when the icebergs must have come out in force, coincided with severe weakening of the Atlantic current system. Those periods are now known as Heinrich events.

As paleoclimate scientists, we use natural records such as sediment cores to understand the past. By measuring uranium isotopes in the sediments, we were able to determine the deposition rate of sediments dropped by icebergs. The amount of debris allowed us to estimate how much fresh

water those icebergs added to the ocean and compare it with today to assess whether history might repeat itself in the near future.

Why a shutdown isn't likely soon

So, is the Atlantic current system headed for a climate tipping point because of Greenland melting? We think it's unlikely in the coming decades.

While Greenland is losing huge volumes of ice right now—worryingly comparable to a midrange Heinrich event—the ice loss will likely not continue for long enough to shut down the current on its own.

Icebergs are much more effective at disrupting the current than meltwater from land, in part because icebergs can carry fresh water directly out to the locations where the current sinks. Future warming, however, will force the Greenland ice sheet to recede away from the coast too soon to deliver enough fresh water by iceberg.

The strength of the Atlantic Meridional Overturning Circulation, or AMOC, is projected to decline 24% to 39% by 2100. By then, Greenland's iceberg formation will be closer to the weakest Heinrich events of the past. Heinrich events, in contrast, lasted 200 years or so.

Instead of icebergs, meltwater pouring into the Atlantic at the island's edge is projected to become the leading cause of Greenland's thinning. Meltwater still sends fresh water into the ocean, but it mixes with seawater and tends to move along the coast rather than directly freshening the open ocean as drifting icebergs do.

That doesn't mean the current isn't at risk

The future trajectory of the Atlantic current system will likely be determined by a combination of the decelerating but more effective icebergs and the accelerating but less influential surface runoff. That will be compounded by rising ocean surface temperatures that could further slow the current.

So, the Earth's pumping heart could still be at risk, but history suggests that the risk is not as imminent as some people fear.

In "The Day After Tomorrow," a slowdown of the Atlantic current system froze New York City. Based on our research, we may take some comfort in knowing that such a scenario is unlikely in our lifetimes. Nevertheless, robust efforts to stop climate change remain necessary to ensure the protection of future generations.

Provided by The Conversation

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